STATUS OF GREEN STURGEON, *ACIPENSER MEDIROSTRIS*, IN CALIFORNIA

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Final Report

Submitted to

National Marine Fisheries Service

Terminal Island, California

May 1992

SUMMARY

The green sturgeon is the most widely distributed but perhaps one of the least studied members of the family Acipenseridae. In North America, it ranges from Alaska to Mexico in marine waters. In the United States, the only known spawning streams at present are the Sacramento River and Klamath River in California and the Rogue River in Oregon. In the recent past, there were probably spawning populations in a number of other rivers as well. Green sturgeon spawn in deep, swift waters during March through July and return to sea soon after spawning. The young spend less than two years in the rivers and estuaries. Sturgeon tagged in the Sacramento-San Joaquin estuary have largely been recaptured outside the estuary, including Washington and Oregon. Adults can reach 2.3 m long and 159 kg with an estimated age of 60 years. Their life history, however, is poorly known. Probably 6,000 to 11,000 adult (< 1.3 m) green sturgeon are harvested every year, mainly in the commercial, sport, and Native American fisheries in Washington. Many, perhaps most, of these fish originate in California. In the Klamath River, a Native American gill net fishery has developed which has been targeting the spawning run in the river. In the Sacramento River, the population is small but fish are harvested in the white sturgeon sport fishery. The fishery data does not show any declining trends, but the data are meager and the increasing fisheries may be "mining" a population of large, old fish. The green sturgeon is apparently extinct Japan and considered to be a potential endangered species in Russia and Canada. We recommend that green sturgeon be managed as a threatened species in California and the United States and that studies begin immediately to learn more about its biology, habitat requirements, and population trends.

INTRODUCTION

The green sturgeon is the most widely distributed member of the ancient family Acipenseridae, the sturgeons. It is also the most marine sturgeon in orientation although it must ascend streams to spawn. Despite the wide distribution of green sturgeon, its biology and status are poorly understood. The southernmost populations of green sturgeon occur in California, a region which has seen a general decline of its anadromous fishes. These two facts, combined with evidence that exploitation of green sturgeon has increased considerably in recent years, has prompted this evaluation of its status in California, which in many respects is also an evaluation of its status in the United States.

BIOLOGY

Description: Green sturgeon are similar in appearance to white sturgeon, *Acipenser transmontanus*, except that the barbels are equidistant or closer to the mouth than to the tip of the long, narrow snout; the dorsal row of bony plates numbers 8-11, the lateral rows 23-30, and the bottom rows 7-10. The dorsal fin has 33-36 rays, and the anal fin 22-28. Body color is olive-green, with an olivaceous stripe on each side.

Taxonomic Relationships: The green sturgeon was described as *Acipenser medirostris* in 1854 by W. O. Ayres from San Francisco Bay, the only one of three species he described from the bay that is still recognized. While there is no question about the validity of this species, the geographic variation in the species has received little attention. It is possible that the Asiatic populations belong to a different taxon although they are morphologically similar to the North American populations and even share some unusual parasites (P. Foley, unpubl.). The Japanese population was described as *Acipenser mikadoi* based on one poorly preserved specimen (Jordan and Snyder 1906).

Distribution: Green sturgeon are amphi-pacific and circumboreal, having been recorded from at least five different countries: Mexico, United States, Canada, Russia (Commonwealth of Independent States), Japan and Korea. As a general rule, they are rarely found below the 30th parallel and greatest abundance occurs between the 40th and 60th parallels. In Asia, they range from the Bering Sea in the north down to Korea and the Japanese islands of Hokkaido and Honshu in the south (Morrow 1980, Borodin et al. 1984). However, green sturgeon are most abundant in Asia in the region of the Tatar Strait, between Sakhalin Island and the Russian coast. The principal spawning stream seems to be the Tumnin (Datta) River.

In North America, the green sturgeon ranges in the ocean from the Bering Sea to Ensenada, Mexico. However, they are found in rivers from British Columbia south to the Sacramento River in California. There is no evidence of green sturgeon spawning in Canada or Alaska, although small numbers have been caught in the Fraser and Skeena rivers (Houston 1988). Green sturgeon are particularly abundant in the Columbia River estuary and individuals had been observed 225 km inland in the Columbia River (Wydoski and Whitney 1979); presently they are found almost exclusively in the lower 60 km and do not occur upstream of Bonneville Dam (Oregon Dept. Fish and Wildlife 1991). There is no evidence of spawning in the Columbia River or other rivers in Washington. In Oregon, juvenile green sturgeon have been found in several of the coastal rivers (Emmett et al. 1991) but spawning has only been confirmed in the Rogue River (A. Smith, ODFW, minutes to USFWS meeting on green sturgeon, Arcata; P. Foley, unpubl.).

In California, green sturgeon have been collected in small numbers in marine waters from the Mexican border to the Oregon border. They have been noted in a number of rivers, but spawning populations are known only in the Sacramento and Klamath Rivers (see below).

Habitat Requirements: The habitat requirements of green sturgeon are poorly known, but spawning and larval ecology probably are similar to that of white sturgeon. Preferred spawning substrate likely is large cobble, but can range from clean sand to bedrock. Eggs are broadcast-spawned and externally fertilized in relatively fast water flows and probably in depths >3 m (Emmett et al. 1991). The importance of water quality is uncertain, but silt is known to prevent the eggs from adhering to each other (C. Tracy, WDF, minutes to USFWS meeting, May 3, 1990, Arcata, Calif.). In the Sacramento River, adult sturgeon are in the river, presumably spawning, when temperatures range from 8° to 14° C.

Life History: The ecology and life history of green sturgeon have received comparatively little study, evidently because of their generally low abundance in most estuaries and their low commercial and sport-fishing value. The adults are more marine than white sturgeon, spending limited time in estuaries or fresh water.

Green sturgeon migrate up the Klamath River between late February and late July. The spawning period is March-July, with a peak from mid-April to mid-June (Emmett et al. 1991). Spawning takes place in deep, fast water. In the Klamath River, a pool known as "The Sturgeon Hole" (1.5 km upstream from Orleans, Humboldt County) apparently is a major spawning site, as leaping and other behavior indicative of courtship and spawning are often observed there during spring and early summer (Moyle 1976). Female green sturgeon produce 60,000-140,000 eggs (Moyle 1976), which are about 3.8 mm in diameter (C. Tracy, minutes to USFWS meeting). Based on their presumed similarity to white sturgeon, green sturgeon eggs probably hatch about 196 hours (at 12.7°C) after spawning, and the larvae should be 8-19 mm long; juveniles likely range in size from 2.0 to 150 cm (Emmett et al. 1991). The juveniles migrate out to sea before 2 years of age, primarily during summer-fall (Emmett et al. 1991). They apparently remain in or near estuaries at first, but can migrate considerable distances as they grow larger (Emmett et al. 1991). Individuals tagged by CDFG in San Pablo Bay (part of the San Francisco Bay system) have been recaptured off Santa Cruz, California, in Winchester Bay on the southern Oregon coast, at the mouth of the Columbia River and in Gray's Harbor, Washington (Chadwick 1959, Miller 1972). Most tags for green sturgeon tagged in the San Francisco Bay system have been returned from outside that estuary (D. Kohlhorst, minutes to USFWS meeting, May 3, 1990).

Juveniles and adults are benthic feeders, and may also take small fish. Juveniles in the Sacramento-San Joaquin Delta feed on opossum shrimp, *Neomysis mercedis*, and amphipods, *Corophium* (Radtke 1966). Adult sturgeon caught in Washington had been feeding mainly on sand lances (*Ammodytes hexapterus*) and callianassid shrimp (P. Foley, umpublished). Adults can reach sizes of 2.3 m FL and 159 kg, but in the California they seldom exceed 1.3 m FL and 45 kg (Skinner 1962). Maximum estimated age for fish in the Klamath River is 60 years (Emmett et al. 1991).

DISTRIBUTION AND ABUNDANCE IN CALIFORNIA

Southern California. A small number of green sturgeon have been reported from the southern California coast (Fitch and Lavenberg 1971). The majority of these fish were less than 100 cm total length (TL) and weighed under 4 kg. The largest green sturgeon reported taken in the ocean south of

Point Conception was a mature male, 163 cm and 25.7 kg, caught by a commercial fisherman near Dana Point, Orange County (Fitch and Schultz 1978).

Abundance of green sturgeon gradually increases northward of Point Conception. They are occasionally caught in Monterey Bay (Gregor Cailliet and Robert Lea, pers. comm.). A tagged green sturgeon was recovered near Santa Cruz, Santa Cruz County (Miller 1972). Within the holdings of the California Academy of Sciences (CAS) is a skeleton collected at Moss Landing Beach, Monterey County, and a complete specimen acquired from the Santa Cruz Municipal Pier Aquarium (David Catania, pers. comm.).

Sacramento-San Joaquin drainage. The San Francisco Bay system, composed of San Francisco Bay, San Pablo Bay, Suisun Bay and the Delta, is home to the southernmost reproducing population of green sturgeon. In fact, green sturgeon were originally described from San Francisco (Ayres 1854). White sturgeon are the most abundant sturgeon in this system and green sturgeon have always been uncommon (Ayres 1854, Jordan and Gilbert 1881). Intermittent studies by the California Department of Fish and Game (CDFG) between 1954 and 1987 have measured and identified 13,982 sturgeon. Based on these data, a green sturgeon to white sturgeon ratio of 1:5 is derived for fish less than 101 cm fork length (FL) and 1:78 for fish greater than 101 cm FL (D. Kohlhorst, pers. comm.). If we assume that sturgeon over 101 cm FL are adults, that green sturgeon and white sturgeon are equally vulnerable to capture by various gear, that green and white sturgeon populations fluctuate in a similar manner, and that the CDFG population estimates of white sturgeon (11,000 to 128,000 depending on the year) are accurate (Kohlhorst et al. 1991), then the adult green sturgeon population in the estuary ranges from 140 to 1,600 fish. These numbers should be regarded, at best, as ball-park estimates. The numbers of juvenile sturgeon are presumably even more variable, depending on episodic reproduction (characteristic also of white sturgeon, Kohlhorst et al. 1991). At the pumps of the federal Central Valley Project in the south Delta, 1,374 green sturgeon were rescued (and recorded) in 1985, 49 in 1986, 91 in 1987, and none in 1988-1990. Variable numbers of green sturgeon have been captured almost yearly since 1968 at the State Pumping Facility (unpubl. CDFG data). The total number caught during the period 1968-1980 was 11,550; of these, 7,311 were recovered in 1974, 2,285 in 1975, 767 in 1978, and 0-423 in each of the remaining years. The annual numbers caught in the last 10-year period (1981-1990) were: 412, 523, 1, 91, 3, 0, 37, 50, 0, and 123.

Indirect evidence indicates that green sturgeon spawn mainly in the Sacramento River. They have been reported in the mainstream Sacramento River as far north as Red Bluff, Tehama County (river km 383) (Fry 1979). Small, young green sturgeon have been taken near Hamilton City, Glenn County (river km 317)(Fry 1979). Additionally, four young green sturgeon were collected at the Red Bluff Diversion Dam in late October, 1991 (Kurt Brown, pers. comm.). River guides have taken adult green sturgeon at the Anderson Hole, about 6 km above the Hamilton Bridge (George Jewell, pers. comm.). A dead adult green sturgeon was found on April 18, 1991, at river km 378 (approximately 5 kilometers south of Dairyville, Tehama County), by biologists from the United States Fish and Wildlife Service (Kurt Brown, pers. comm.). Live adult green have been observed by USFWS crews surveying winter-run chinook salmon, *Oncorhynchus tshawytscha* (Walbaum,1792), in the 16 km reach of river below Red Bluff Diversion Dam in 1991 and 1992 (Kurt Brown, pers. comm.). In 1991, 20 large sturgeon were sighted between April 3 and May 21. Some spawning may also take place (or did once) in the lower San Joaquin River, as young green sturgeon have been taken at Santa Clara Shoal, Brannan Island State Recreational Area, Sacramento County (Radtke 1966) and a single specimen from Old River is in the CAS collection (D. Catania, pers. comm.).

North Coast. North of San Francisco, green sturgeon are encountered with greater frequency. They are recorded from Tomales Bay (Blunt 1980, Dave Catania, pers. comm.) and, while numbers are small, they are roughly equal in abundance to white sturgeon (Richard Plant, pers. comm.). A tagged green sturgeon was recovered near Bodega Head (D. Kohlhorst, pers. comm.) and small numbers are taken incidentally by a near-shore halibut fishery centered at Bodega Bay (C. Haugen, pers. comm.). Further north, a single specimen was collected from the Noyo River (D. Catania, pers. comm.).

Between San Francisco Bay and the Klamath River, it is likely that most records of sturgeon caught in rivers refer to green sturgeon. However, most early references to sturgeon from this area failed to identify the species and some reports indicated white sturgeon to be more abundant (Fry 1979). As result, much confusion has ensued as to the relative abundance of both species throughout this region. The only river with apparent spawning runs of green sturgeon in this region was the Eel River. Accounts from 19th century newspapers provide the earliest evidence of sturgeon in the Eel River drainage. At this time sturgeon were reported from the mainstem Eel River, South Fork of Eel River and the Van Duzen River (Wainwright 1965). For example, the newspaper reported on August 6, 1877, that "more than one hundred large sturgeon were killed in one deep place in the Eel River, near the mouth of Van Duzen in the last month." Individual sturgeon were reported only if they were of exceptionally large size which generally meant 2 to 2.5 m in length and in excess of 45 kg. This would be large for a green sturgeon but not for a white sturgeon. Green sturgeon are also indicated as the Eel River species by a reference to Native Americans capturing sturgeon because they knew "whites did not care for this sort of fish (May 19, 1887)"

In the middle part of this century, two young green sturgeon were collected in the mainstem Eel River and large sturgeon were observed jumping in tidewater (Murphy and DeWitt 1951). Two additional young green sturgeon were taken from the Eel River in 1967 and are in the collection of the Humboldt State University Fish Museum. More recently, green sturgeon have been included in lists of natural resources found in the Eel River Delta (Monroe and Reynolds 1974, Blunt 1980). However, there are no confirmed records of green sturgeon in the Eel River since 1967.

Records of sturgeon in the Humboldt Bay system, comprising Arcata Bay to the north and Humboldt Bay to the south, are almost exclusively green sturgeon. Ten years of trawl investigations in South Humboldt Bay produced three green sturgeon (Samuelson 1973). Records from Arcata Bay are more numerous. On August 6 and 7, 1956, 50 green sturgeon were tagged in Arcata Bay by CDFG biologist Ed Best (data recovered from CDFG files by D. Kohlhorst, pers. comm.). Total length ranged from 57.2 cm to 148.6 cm with a mean TL of 87.0 cm ($\pm$ 20.6 cm SD). In 1974, nine green sturgeon were collected over a two-month period in Arcata Bay (Sopher 1974). Total length of these fish ranged from 73 cm to 112 cm.

The Coast Oyster Company, Eureka, pulled an annual series of trawls in Arcata Bay as a means of decreasing the abundance of bat rays, *Myliobatis californica*. Green sturgeon are incidentally taken in this operation. Eight green sturgeon collected for parasite evaluation in 1988 and 1989 had total lengths ranging from 78 to 114 cm. One large individual, 178 cm TL and 18.2 kg, was returned to the bay. A single white sturgeon, estimated 100-150 cm TL, was captured during 1989.

Green sturgeon have been reported from the Mad River, although the river is probably too small to support a spawning run (Fry 1979). Recent evidence of their presence is scant and any green sturgeon in the Mad River would likely be limited to the estuary (Bruce Barngrover, pers. comm.).

An occasional green sturgeon is encountered in the coastal lagoons of Humboldt County (Terry Roelofs, pers. comm.). Big Lagoon and Stone Lagoon are connected to the ocean during part of the year and any migrating sturgeon may gain entry at this time. In June, 1991, a 120 cm green sturgeon was gill netted in Stone Lagoon (Terry Roelofs, pers. comm.).

Klamath and Trinity Rivers. The largest spawning population of green sturgeon in California is in the Klamath River Basin. Both green sturgeon and white sturgeon have been found in the Klamath River estuary (Snyder 1908, USFWS 1980-91) but white sturgeon are taken infrequently, and presumed not to spawn in the river (USFWS 1982). A sturgeon investigation program initiated in 1979 by USFWS found that almost all sturgeon occurring above the estuary were green sturgeon (USFWS 1980-83). The sturgeon primarily use the mainstem Klamath River and mainstem Trinity River, but have also been seen in the lower portion of the Salmon River.

Both adults and juveniles have been identified in the mainstem Klamath River. Adults are taken annually, spring and summer, by an inriver Native American gill net fishery. The numbers average around 500 fish per year (see below). They have also been taken by sport fishermen as far inland as Happy Camp (river km 172) (Tagging Data 1969-73, Fry 1979, USFWS 1981). However, the apparent limit for the spawning migration is Ishi Pishi Falls, upriver from Somes Bar, Siskiyou County (approximately river km 113). A few juveniles have been taken as high up as Big Bar (Tom Kisanuki, pers. comm.) but most have been recovered by seining operations directed at salmonids in the tidewater (USFWS, CDFG).

The Trinity River enters the Klamath River at Weitchpec (river km 70). The earliest green sturgeon described from the Klamath Basin came from the Trinity River (Gilbert 1897). Both adults and juveniles have been identified. 211 sturgeon, between 7 cm and 29 cm TL, were captured near Willow Creek, Humboldt County, incident to a salmonid migration study in July, August and September of 1968 (Healey 1970). Adults are caught yearly in a Native American gill net fishery (USFWS 1980). Spawning migrants penetrate the mainstem Trinity River up to about Grays Falls, Burnt Ranch, Trinity County (river km 72).

Sturgeon have also been reported to use the South Fork Trinity River, a third order stream entering above Willow Creek (river km 51) (USFWS 1981). Oral histories from old-time residents confirm this. However, a large flood in 1964 had devastating effects on anadromous fish habitat in this subbasin (United States Department of the Interior 1985). Millions of cubic yards of soil were moved into South Fork Trinity River and its tributaries. Channel widening and loss of depth resulted. This event, along with other changes in subbasin morphology, has apparently resulted in the loss of suitable sturgeon habitat. There are no recent sightings from this watershed.

The Salmon River is a second order stream entering the Klamath River at Somes Bar (river km 106). The water in this river is generally clear and becomes turbid only during high run-off periods. Adult sturgeon have been seen swimming in this river by observers standing on bluffs overhead. The approximate limit to upriver migration is at the mouth of Wooley Creek, a third order stream (river km 8). Juveniles have yet to be found in the Salmon River, however.

Del Norte County. Green sturgeon have been taken during gill net sampling in Lake Earl (D. McCloud, pers. comm.). Lake Earl is located along the coast of Del Norte County, 8 km north of Crescent City and 11 km south of the mouth of Smith River. It is connected by a narrow channel to Lake Talawa, a smaller lake directly to the west. A sand spit separates Lake Talawa from the ocean and is

occasionally breached by winter storms or humans. Green sturgeon enter at this time and become trapped after the sand spit is rebuilt (Monroe et al. 1975).

The Smith River is the northernmost river along the California coast, entering the ocean approximately 5 km south of the Oregon border. Blunt (1980) included green sturgeon in an inventory of anadromous species found in Smith River. They occasionally enter the estuary and have been observed in Patrick's Creek, an upstream tributary 53 km from the ocean (Monroe et al. 1975). Juveniles have not been found.

FISHERIES

The green sturgeon generally has been held in lower esteem by fishermen than the white sturgeon because it has darker flesh, is much less abundant and smaller in size, and it spends less time in fresh water or estuaries, thereby being harder to catch. In the past, it was rarely targeted as a commercial or sport fish but was caught incidental to catches of white sturgeon. This is still largely true today, but concentrations of them are targeted by commercial fishermen in Washington and Oregon and a fairly intense fishery for spawning fish has developed on the Klamath River, by Native Americans. Fisheries for green sturgeon exist mainly in three areas: the Columbia River region, the Klamath and Trinity Rivers, and the Sacramento-San Joaquin estuary.

Columbia River Region. The majority of the green sturgeon harvest occurs in this region; they are caught by commercial fishermen, anglers, and Indian gill netters. Sturgeon landings are recorded from the Columbia River estuary and from Grays Harbor and Willapa Bay, Washington, to the immediate north of the estuary. There is little or no evidence of green sturgeon spawning in the rivers of this region, and it is likely that the fish harvested here migrated from Oregon or California, as indicated by limited recaptures of tagged sturgeon. Further evidence of the lack of local recruitment into the fishery is that few juvenile sturgeon (< 1.3 m) are caught (Emmett et al. 1991).

The commercial catch in the Columbia River region (Columbia River estuary, Grays Harbor, Willapa Bay) has fluctuated considerably, but catches seem to have increased in recent years. Between 1941 and 1951, catches averaged about 200-500 fish per year, while between 1951 and 1971 the catch averaged about 1,400 fish per year (Houston 1988). In recent years an average of 4.7 tons of green sturgeon (ca. 500-1,000 fish) have been harvested each year in Grays Harbor and 15.9 tons (ca. 2,000-4,000 fish) have been harvested in Willapa Bay (Emmett et al. 1991). There have also been some notably high catches. In 1986, about 5,000 green sturgeon were harvested in the estuary alone during a four-day sturgeon fishing season (Emmett et al. 1991). The 1990 commercial catch in the estuary was about 2,200 fish; the recreational catch, which has been consistently below 500 fish per year, was 100 fish in 1990 (Oregon Dept. Fish Wildlife 1991). The catch of the Indian gill net fishery is not known. Overall, the fisheries in Washington and Oregon seem to be taking 5,000-10,000 adult green sturgeon per year.

Klamath and Trinity Rivers. A small number of green sturgeon are probably taken in the sport fishery here, but the main harvest is by the Indian gill net fishery. This fishery targets the fish as they move up the river to spawn during the spring and again on fish returning seaward through the estuary, during June-August (USFWS 1990). Mainly adult sturgeon (< 130 cm FL) are captured (mean length 179 cm FL in 1988). Data on this fishery exist only for 1980-1989 and the available harvest estimates (USFWS 1989) may be biased (low) by variable and inconsistent sampling effort. With that in mind, the adult harvest estimates for the Klamath system range between 158 fish in 1987 to 810 in 1981, with a

mean of 398 (USFWS 1989, 1990). There seems to be, as yet, no indication from the catches of any recent decline. However, the fishery for green sturgeon is a relatively recent development and is likely to increase as increased restrictions are placed on the harvest of depleted salmon populations in the rivers.

Sacramento-San Joaquin estuary. Green sturgeon in this estuary are caught primarily by anglers who are fishing for white sturgeon. If we assume that green sturgeon > 102 cm (official legal size) are harvested in proportion to their numbers relative to white sturgeon and at the same rate, then exploitation rates have been gradually increasing since 1954 (Kohlhorst et al. 1991). Recent annual harvest rates for white sturgeon have been 8-11.5% per year, which is regarded as excessive for such a long lived species which seems to depend on strong year classes produced during years of exceptionally high outflow. Kohlhorst et al. (1991) consequently recommend that mortality rates be reduced by increasing the minimum harvest size of sturgeon to 130 mm. This size limit would also allow more females to mature, as female white sturgeon mature at larger sizes than males. Presumably such an increased size limit would also benefit green sturgeon.

STATUS

We regard the green sturgeon as a threatened species. This status recommendation can be regarded as conservative, but it errs, if at all, to the benefit of a species about which we know surprisingly little. The following are reasons for which we recommend this status in California and, consequently, in the United States.

1. The green sturgeon appears to be in trouble throughout its range. Rochard et al. (1990) state in their review of the status of sturgeons worldwide: "Those [species of sturgeon] which do not have particular interest to fishermen(*A. medirostris, Pseudoscaphirhynchus* spp.) are paradoxically most at risk, for we know so little about them (p. 131)." In Japan, green sturgeon have apparently been extinct for 40 or more years (K. Amaoka, pers. comm.), even though they once had spawning runs in the rivers of Hokkaido (Otaki 1907). In Russia, the green sturgeon is listed as a Category 4 species (probably endangered but with insufficient information to be classified as such). Borodin et al. (1984) note that is has been little studied but "appears to be in great danger of extinction." Fishing for green sturgeon is now officially forbidden in Russia. In Canada, green sturgeon have been given "rare" status (1987) by the Committee on the Status of of Endangered Wildlife in Canada based on a general lack of information on their biology and their uncommoness (Houston 1988).

2. A number of presumed spawning populations have apparently been lost in the last 25-30 years (Eel River, South Fork Trinity River, San Joaquin River) and the only known spawning populations are in the Sacramento, Klamath, and Rogue rivers, all of which have flow regimes affected by water projects. It is quite likely that these are now the only spawning populations in North America.

3. The various fisheries are harvesting at least 6,000 to 11,000 green sturgeon per year. While there is no direct evidence of a decline, the statistics are very incomplete and it highly likely that fishing pressure has been increasing in recent years. Particularly worrisome developments are the increasing fisheries in the Columbia River region and the developing Indian gill net fishery on the Klamath River, which targets the largest known spawning population. It is possible that the present fisheries are "mining" a stock of large, old fish that cannot renew itself at present harvest rates.

4. The principal fisheries for green sturgeon are in Washington and in the nearby Columbia River estuary, yet there is no evidence of sturgeon spawning in the region. It is quite possible that these

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